SEISMIC LOCATION CALIBRATION IN THE MEDITERRANEAN,

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Sponsored by Defense Threat Reduction Agency

Research accomplished

The Group 2 Consortium carries out the location calibration for seismic stations in the Mediterranean, North Africa, Middle East and Western Eurasia. We follow a model-based approach to develop path-dependent travel-time corrections. The project is divided into two phases. In Phase 1, which ended in Spring 2002, we developed preliminary corrections and demonstrated improvements due to calibration. Currently we are in the development stage of Phase 2, the final delivery is due in February, 2003.

Summary of Phase 1 results

- Employed CUB1.0 global upper mantle and Harvard SP12 global whole mantle P and S velocity models to compute regional and teleseismic SSSCs, respectively
- Collected and validated some 900 GT0-10 reference events
- Pn and Sn SSSCs for IMS stations were tested (online and offline), validated and delivered to CMR RDSS in 2001
- achieved statistically significant variance reduction, location improvements and decrease in the area of error ellipses
- Phase 1 delivery has been approved by the CMR Configuration Control Board

Phase 2

- We employ improved global 3D models, CUB2.0 and J362D28 (both incorporating CRUST2.0) to calculate regional and teleseismic correction surfaces, respectively
- We use substantially larger, carefully vetted set of reference events and
- Empirical path corrections derived from event cluster analysis to validate models and predicted corrections
- Explore novel approaches to validate correction surfaces
- Preparations for a comprehensive relocation study are under way.

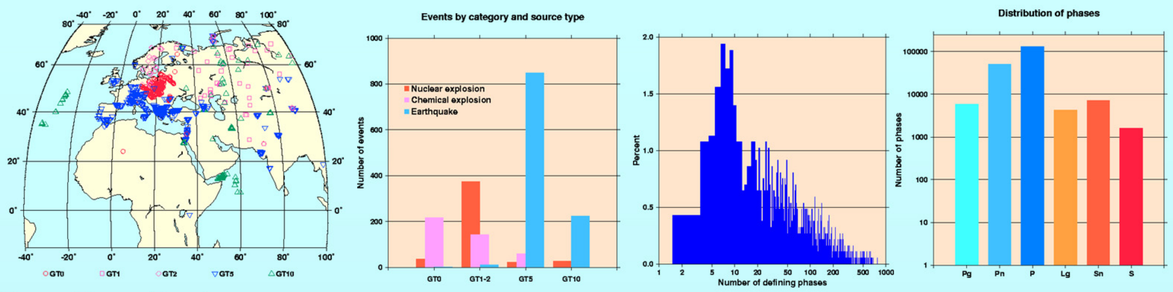
Reference Events

GT5 candidate event selection criteria at the 95% confidence level

- at least 10 stations within 250 km from the epicenter with an azimuthal gap less than 110° and a secondary azimuthal gap less than 160°
- at least one station within 30 km from the epicenter
- the event is recorded beyond 250 km.

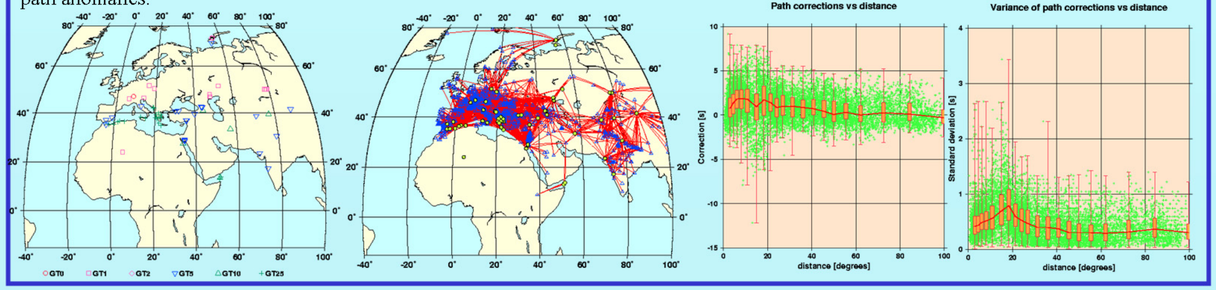
Reference Event List 2.1.

The current list of reference events consists of nearly 2,000 GT0-10 events. The Reference Event List can be browsed at http://g2calibration.cmr.gov/calibration/refsel.html. Each event in the list is documented with metadata.



Event Cluster Database

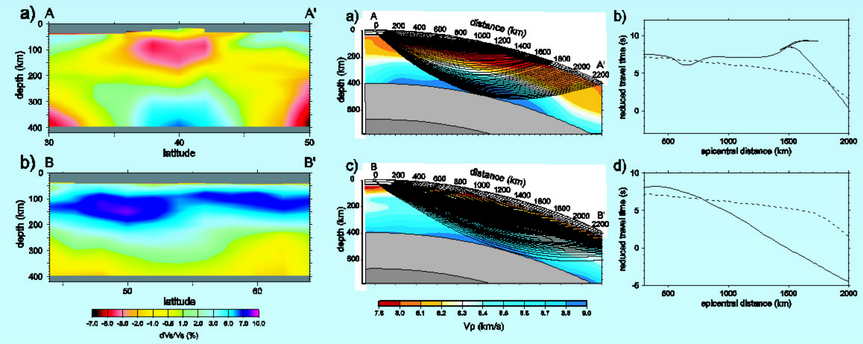
Reference event candidates are validated using multiple event location techniques such as Hypocentroidal Decomposition (HDC) and Joint Hypocenter Determination (JHD). Event cluster analysis also provides empirical path-dependent station corrections which are used to validate both models and predicted correction surfaces. The database contains some 4,000 regional and some 7,770 teleseismic empirical path anomalies.



Model development

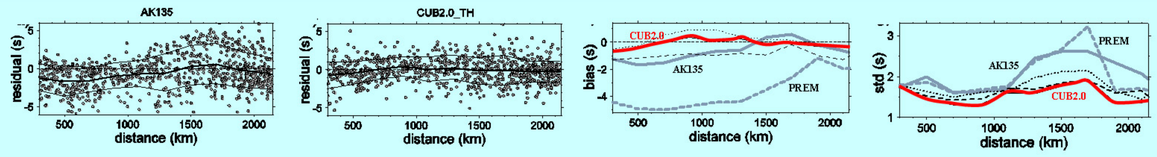
CUB2.0

The CUB2.0 model is a diffraction tomography model obtained by the Monte Carlo inversion of phase and group velocity dispersion curves. S velocities are converted to V_P based on mineralogical partial derivatives for a hypothetical composition of the upper mantle rather than a simple empirical relation between V_S and V_P. Path-dependent corrections are calculated via ray-tracing.



Vertical cross-sections from the CUB2.0 P model along tectonic (5°E, from Belgium to Algeria) and platform (55°E, Russian platform) paths. The actual ray paths and the predicted travel times demonstrate that Pn can exhibit very complex behavior.

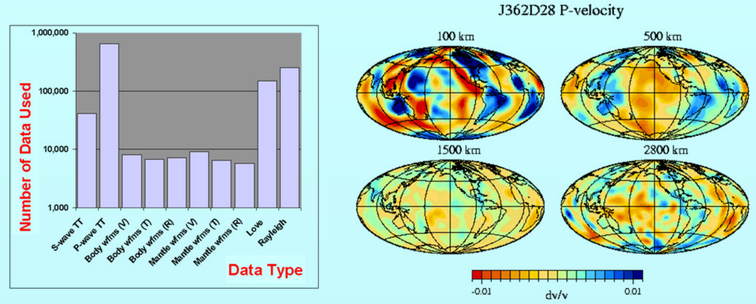
Residuals between empirical path anomalies and Pn predictions from the AK135 and CUB2.0 models versus epicentral distance. The running residual bias and standard deviation versus distance are shown for several models.

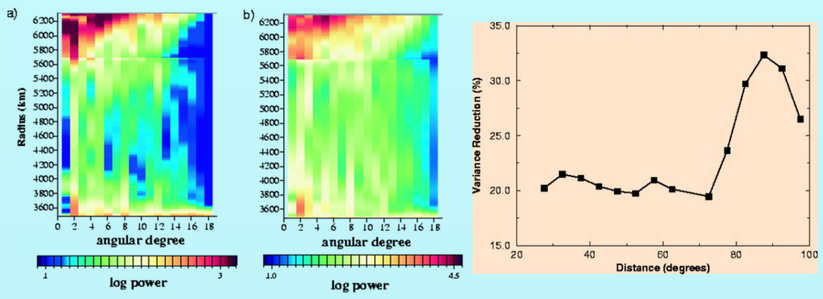


J362D28

J362D28 is a joint compressional and shear wave velocity model of the Earth's mantle obtained by the inversion of both body and surface wave data. It is parameterized by 362 spherical splines (approximately equivalent to spherical harmonic degree 18 in resolution) and 6 and 8 radial splines in the upper and lower mantle.

Distribution and type of data used in the inversion for J362D28 (left). J362D28 compressional velocity variations at 100, 500, 1500 and 2500 km depths with respect to the average structure at that depth (right).





Log power spectra of P and S velocities for spherical harmonic degrees 1-18. Power in degree 2 does not drop abruptly in amplitude at 670 km for P velocity structure as it does for S. Degree 2 power remains the highest for P velocity throughout the mantle. Right: variance reduction versus epicentral distance in 5° bins for P travel-times.